PATENT SPECIFICATION

NO DRAWINGS

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COMPLETE SPECIFICATION

Improvements in or relating to Light Transmitting Polymeric Sheet

We IMPERIAL CHEMICAL INDUSTRIES LIMITED, of Imperial Chemical House, Millbank, London, S.W.1., a British Company do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to improvements in light transmitting polymeric sheet, particularly such sheet that is used for back projections or as an illuminated panel.

The technique of back projection is well known in the cinema and television industries and also for display and educational purposes. For this purpose a light transmitting screen is used such that when an image is projected on to one surface of the screen, the image is distinctly visible to observers viewing the opposite face of the screen.

Also attractive lighting systems can be provided by means of light transmitting panels which are illuminated from behind.

An object of this invention is to provide light transmitting sheet of polymeric material that is particularly effective for use in a back projection system or for use in lighting systems incorporating illuminated panels, either flat or shaped forms.

Accordingly the present invention provides a process for making light transmitting sheet in which a polymerisable liquid that normally polymerises to form a transparent solid polymer is polymerised in known manner in a casting cell to form a flat sheet while the cell is maintained in a horizontal position, said liquid comprising a monomer containing a single $CH_2=C\diagup\diagdown$ group per molecule and having uniformly dispersed within it when introduced into the casting cell insoluble translucent solid particles, the particles having maximum linear dimensions within the range 2 to 2,000μ, a refractive index for the sodium D line that differs from the refractive index of the solid polymer formed by polymerisation of said liquid by at least 0.05 but by not more than 1.5, being in such quantity that their total surface area is from 1 to 50 times the area of the lower surface of the layer of liquid in the cell, and the viscosity of said liquid being such that the particles settle in the casting cell to form a thin uniform layer adjacent said lower surface before polymerisation is effected.

Further in accordance with our invention we provide a light transmitting sheet of organic polymeric material having immediately adjacent one of the larger surfaces of the sheet a uniform layer of solid particles each having a maximum dimension within the range of 2 to 2,000μ, a refractive index for the sodium D line that differs from the refractive index of the polymeric material by at least 0.05 but by not more than 1.5, and the particles forming the layer having a total surface area that is equal to from 1 to 50 times the surface area of the polymeric sheet adjacent thereto.

Methyl methacrylate is the monomeric liquid that is most particularly preferred for use in our process because it forms dimensionally stable sheets which have a high light transmission and which have a high stability to the effect of light. The methyl methacrylate may be used by itself, or in admixture with other ethylenically unsaturated monomers e.g. the alkyl esters of acrylic acid containing from 1 to 8 carbon atoms in the alkyl moiety, or the N-substituted phenyl maleimides. Where a mixture of methyl methacrylate with another ethylenically unsaturated copolymerisable com-

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pound containing a single ethylenically unsaturated group per molecule is used we prefer in general that the methyl methacrylate should form at least 60% by weight of the polymerisable materials.

The monomeric liquid that polymerises to form the sheet may contain up to 5% of its weight of a copolymerisable monomer containing at least two $CH_2=C$ groups per molecule e.g. glycol dimethylacrylate, triethylene glycol dimethacrylate or divinyl benzene. By this means the final polymeric sheet is rendered less thermoplastic.

The liquid is preferably used in the form of a syrup consisting of a solution of the said polymer in the monomer. Such syrups may be prepared by dissolving the polymer in the monomer or by partially polymerising the monomer. By whichever process the syrup is formed it should be ensured that the viscosity is not too high since otherwise settling of the solid particles may be unduly retarded. For this reason we prefer that the viscosity of the syrup should lie within the range of 0.1 to 10 poises.

The process of casting liquid monomer in a casting cell to form a solid sheet is well known in the art. The cell normally used takes the form of two glass plates clamped together with a resilient peripheral gasket holding them apart by the required distance. The monomer or syrup is poured through an opening in the gasket to fill the cell and the opening is then sealed off. The cell is then maintained in the process of the present invention in a horizontal position to allow the solid particles to settle, and then under such conditions to allow the monomer to polymerise. The latter step is normally carried out at an elevated temperature, in the case of methyl methacrylate at temperatures of from 40° C to 80° C. It will be appreciated, that where polymerisation takes some hours to complete, no special steps need be taken to ensure that the solid particles have settled, because there will be adequate time for settling to be complete before the onset of polymerisation.

The monomeric liquid preferably contains in solution a small concentration of a polymerisation initiator. Such compounds are well known in the art and include for example benzoyl peroxide, lauroyl peroxide, and other organic peroxides and the azo catalysts, e.g. α,α'-azodi-isobutyronitrile. Polymerisation can also be effected by means of light active catalysts, or by means of low temperature catalysts.

Any translucent particles that meet the requirements hereinbefore specified may be used in our invention. Examples include aluminium oxide, titanium dioxide, zinc carbonate, barium sulphate, calcium carbonate, calcium silicate, calcium magnesium ortho silicate, calcium molybdate, anhydrous calcium sulphate, calcium oxide, calcium sulphide, magnesium aluminate, mica, lead carbonate, zinc oxide and zinc sulphide. Preferably the particle size is such that the particles have a maximum dimension of 10 to 100μ. It is preferred that the refractive index for the sodium D line of the particles should differ from the refractive index of the polymer of the sheet by at least 0.1 but by not more than 0.4. It is also preferred that the total surface area of the particles should be from 3 to 10 times the area of the lower surface of the layer of liquid in the casting cell. Ideally, we prefer that the solid particles should form a single layer of thickness substantially equal to maximum particle size dimension in the sheet.

We further prefer that the particles should be so selected that they are held in suspension in the monomeric liquid for a time sufficient to enable the liquid to be poured into the cell without the particles settling out before the cell is filled and placed in a horizontal position.

The monomer liquid may be coloured if desired by means of dyestuffs e.g. to give a grey neutral tone to the sheet, particularly for the purpose of increasing the contrast in the projected image on the screen. A small amount of dark coloured insoluble particles may be included for this purpose in said layer of particles. Examples of suitable materials include copper oxide, carbon black, slate powder, silicon carbide and metal powders.

Ancillary ingredients of known kind, e.g. light stabilisers and antistatic agents may be included in the polymerisation material.

Our polymeric sheets are extremely useful as back projection screens. They can also be used for illuminated signs, particularly when some kind of changing image is projected on the screen to provide the sign. Another use for which they are suitable is in illuminated ceilings, where our sheets provide a panel that is illuminated by a source of light above the panel.

Our invention is illustrated in the following Example in which all quantities expressed in parts are by weight.

EXAMPLE

97.85 parts of methyl methacrylate were partially polymerised by heating at 80° C for 100 minutes while containing in solution 0.0015 part of α,α'-azodi-isobutyronitrile to form a syrup having a viscosity of 2 poises.

The following materials were then added to the syrup:—

Titanium dioxide (surface area 30 sq. ft./oz.) (particle size 2—100μ)	2 parts
Copper Oxide	0.1 part
α,α'-azodi-isobutyronitrile	0.05 part

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The mixture was well stirred and poured into a casting cell formed by two rectangular sheets of glass 3 ft.×4 ft., separated by a continuous flexible edge gasket 1/8" thick. The cell was supported in a horizontal position for 6 hours and then heated to 65° C until the polymerisable material was hard. At the end of this time the glass sheets were separated from the sheet of polymethyl-methacrylate made by the process.

The polymeric sheet had a thin uniform layer of insoluble particles adjacent to one surface of the sheet. When the sheet was used as a back projection screen with the image directed on to either surface it gave a very bright well defined image that was visible over a wide viewing angle.

WHAT WE CLAIM IS:—

1. A process for making light-transmitting sheet in which a polymerisable liquid that normally polymerises to form a transparent solid polymer is polymerised in a casting cell to form a flat sheet while the cell is maintained in a horizontal position, said liquid comprising a monomer containing a single $CH_2=C\diagup\diagdown$ group per molecule and having uniformly dispersed within it when introduced into the casting cell insoluble translucent solid particles, the particles having maximum linear dimensions within the range 2 to 2,000μ, a refractive index for the sodium D line that differs from the refractive index of the solid polymer formed by polymerisation of said liquid by at least 0.05 but by not more than 1.5, and being in such quantity that their total surface area is from 1 to 50 times the area of the lower surface of the layer of liquid in the cell, and the viscosity of said liquid being such that the particles settle in the casting cell to form a thin uniform layer adjacent said lower surface before polymerisation is effected.

2. A process according to Claim 1 in which said monomer is methyl methacrylate.

3. A process according to Claim 1 in which said monomer is a mixture of methyl methacrylate and a copolymerisable compound containing a single ethylenically unsaturated group per molecule, the mixture containing at least 60% by weight of methyl methacrylate.

4. A process according to any one of the preceding claims in which said liquid is in the form of a syrup consisting of a solution of the said polymer in the monomer.

5. A process according to Claim 4 in which said syrup has a viscosity of 0.1 to 10 poises.

6. A process according to any one of the preceding claims in which said polymerisable liquid contains up to 5% of its weight of a copolymerisable monomer containing at least two $CH_2=C\diagup\diagdown$ groups per molecule.

7. A process according to any one of the preceding claims in which said solid particles consist of aluminium oxide, titanium dioxide, zinc carbonate, barium sulphate, calcium carbonate, calcium silicate, calcium magnesium ortho-silicate, calcium molybdate, anhydrous calcium sulphate, calcium oxide, calcium sulphide, magnesium aluminate, mica, lead carbonate, zinc oxide or zinc sulphide.

8. A process according to any one of the preceding claims in which the particles have a maximum linear dimension of 10 to 100 microns.

9. A process according to any one of the preceding claims in which the refractive index of the sodium D line of the particles differs from that of the polymer formed by polymerisation of said liquid by at least 0.1 but not more than 0.4.

10. A process according to any one of the preceding claims in which the total surface area of the particles is from 3 to 10 times the area of the lower surface of the layer of liquid in the casting cell.

11. A process according to any one of the preceding claims in which the solid particles form a layer of thickness substantially equal to the maximum linear dimension of the particles in the sheet.

12. A process according to any of the preceding claims in which a small amount of dyestuff is added to the monomeric liquid to give it a grey neutral tone.

13. A process substantially as hereinbefore described with respect to the Example.

14. A light transmitting sheet whenever made by a process according to any of the preceding claims.

15. A light transmitting sheet of organic polymeric material having immediately adjacent one of the larger surfaces of the sheet a uniform layer of solid particles each having a maximum linear dimension within the range of 2 to 2,000μ, a refractive index for the sodium D line that differs from the refractive index of the polymeric material by at least 0.05 but by not more than 1.5, and the particles forming the layer having a total surface area that is equal to form 1 to 50 times the surface area of the polymeric sheet adjacent thereto.

16. A sheet according to Claim 15 in which said organic polymeric material is polymethyl methacrylate or a copolymer of a mixture of methyl methacrylate and a copolymerisable compound containing a single ethylenically unsaturated group per molecule, the mixture containing at least 60% by weight of methyl methacrylate.

17. A sheet according to Claims 15 or 16 in which said solid particles consist of aluminium oxide, titanium dioxide, zinc car-

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bonate, barium sulphate, calcium carbonate, calcium silicate, calcium magnesium orthosilicate, calcium molybdate, anhydrous calcium sulphate, calcium oxide, calcium sulphide, magnesium aluminate, mica, lead carbonate, zinc oxide or zinc sulphide.

18. A sheet according to any one of Claims 15 to 17 in which the particles have a maximum linear dimension of 10 to 100 microns.

19. A sheet according to any one of Claims 15 to 18 in which the refractive index of the sodium D line of the particles differs from that of the polymer forming the sheet by at least 0.1 but not more than 0.4.

20. A sheet according to any one of Claims 15 to 19 in which the total surface area of the particles is from 3 to 10 times the area of the lower surface of the layer of liquid in the casting cell.

21. A sheet according to any one of Claims 15 to 20 in which the solid particles form a layer of thickness substantially equal to the maximum linear dimension of the particles in the sheet.

22. A back projection screen comprising a light transmitting sheet according to Claims 14 or 15 to 20.

23. An illuminated sign comprising a light transmitting sheet according to Claims 14 or 15 to 20.

24. An illuminated ceiling comprising a light transmitting sheet according to Claims 14 or 15 to 20.

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